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Becoming and being an Engineer in an internationalised context: students' constructions of their experiences in Higher Education

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*'It's not like bookwork... it's designed in such a manner that you have to think in your own way'
(student comment)*

Introduction

As Engineering activities become more socio-technical in nature (Lemaitre et al, 2006), Engineering education is being required to place more emphasis on competences that enable postgraduates to operate as Engineers in an international community in the 21st Century (Borri, Gubert and Melsa, 2007). Students are thus being encouraged to develop a wider range of complex skills and competences that include an ability to engage with real world problems and the development of robust identities as Engineering professionals. This range of competences and higher order skills being required by professional bodies to achieve professional registration and for the accreditation of courses is played out against an increasingly diverse social and cultural context. There are vast differences in educational background, academic background, professional experience, age, language and culture represented in student groups (Abanteriba, 2006).

This paper relates to a research project that charts the complex development of engagement and professional identities in a group of international students (including British students) on an MSc course in Engineering. A detailed picture of the diversity of students' social, cultural and educational backgrounds at entry is placed against the development of students' skills and competences as they move towards their summative assessments. Students' awareness and development of ideas about what it means to be an Engineer in an international context are also prominent in the project. Through survey, observation and interview data, the case study focuses on the socio-cultural background to learning in Engineering. It also presents a qualitative picture of how students build their technical and higher skills, competences and identities as professional Engineers.

This research was carried out in the Centre for Excellence in Teaching and Learning in Assessment for Learning (CETL AfL) and forms part of a wider research project that focuses upon the powerful function of different forms of assessment in student learning. In its broadest sense, AfL advocates approaches that recast the emphasis of teaching and learning from summative assessment (that may encourage strategic approaches to learning), to integrated and formative approaches (that support students towards their final summative assessments) (McDowell et al, 2005). The modules under consideration in this case study have had a range of AfL approaches implemented in them, and thus the results from this research may indicate improvements in student engagement and learning that are a result of a range of approaches and innovations. This particular aspect of the project aims to show that approaches such as the

sustained use of tutors' own research in teaching can contribute to improving student learning and achievement. In addition to this, external 'experts' from industry were called in to provide examples of 'real-world' enquiry. In personalising the research and examples in this way, it was envisaged that students would be motivated to engage more actively and deeply with the subject.

This case study in Engineering was initiated by a concern for summative assessment outcomes in a series of modules on the MScs in Mechanical and Product Engineering that were producing a notable bi-polar marks distribution in students' final assessments. This was occurring within modules characterised by the requirement of students to work with complex, incomplete or contradictory data in unfamiliar situations and which require students to demonstrate initiative and originality in problem solving. Students were either achieving highly in the module assessments or clearly demonstrating an inability to work with the concepts and ideas of the module. The aim of the research is to investigate the detail and the nature of this outcome through consideration of students' individual and diverse social, cultural and educational backgrounds. This is set against students' developing views of their engagement with the course, their informal learning and their views of what it meant to them to 'be an Engineer' and how they see their future career. The detailed profiles of each student are also considered against their achievements in their final summative assessments. The intention is thus to identify aspects of students' social, cultural and educational backgrounds that enabled them to engage successfully with learning, teaching and assessment, and also to highlight factors that appeared to be barriers to their success.

Methodology and data

One cohort of students was chosen to take part in the research, comprising 44 students of diverse social, cultural and educational backgrounds following a range of MSc Mechanical Engineering modules. Students were given a detailed survey to complete at the beginning of their course, in order to provide the project with contextualised knowledge of their socio-cultural and educational backgrounds. In addition to seeking this information, their perceived competences in maths, measurement and computing were asked for, and details of their prior learning experiences were canvassed. Class observations were undertaken over a period of two semesters, and fifteen students were interviewed using semi-structured interviews. The interviews discussed their perception of their engagement with the course, their experience of informal learning in a diverse cultural setting, the development of their understandings, and their perceived identities in relation to becoming an engineer. Students' written work and assignments were also considered.

Findings: the interview data

The students in the group were interviewed about their perceptions of how they engaged with the content of the course, with their tutors, with informal learning; also, how they perceived themselves as professional Engineers involved in problem-solving and research in a realistic context.

The importance of engagement with research in the modules

There was a strong case for developing research skills in self-reliance and 'enquiry' within these taught modules, as they are taken before the students' major independent project, their dissertation. Perhaps as a result of this, alongside the innovations introduced, students on these modules fore-grounded aspects of their course that related to research in Engineering. The research presented to them by their tutors, as the fundamental basis of the modules, and the research that they engaged in themselves as part of the course, was seen to be a significant factor in their learning. This was another factor that distinguished their learning experience in the UK from their prior learning. One student said:

'The study here concentrates on research and how to improve your ability to work on the research...to help you to solve the problems'

One other student particularly noted the importance for him of the inclusion of external examples of research from 'real' industrial contexts. This is strengthened by bringing in speakers from outside the university to talk to students about examples of research and problem solving in industrial situations. He suggested that such examples of real-world Engineering explained to them face-to-face by the person who has conducted the research or project enables them to contextualise the issues and transfer conceptual ideas into practice:

"Whatever tutors tell us, that is just bookish knowledge. I mean, we may learn just to get the grades or get score marks but then we won't get any practical knowledge with that. Unless we see things in practice, how they are happening we won't get that knowledge."

The approaches to teaching and learning in this project appear to be fore-grounding the application of concepts and ideas into practice for the students. It also appears from the student quote above, that the Assessment for Learning approaches are inherent in students' perceptions of what is important in their learning. The student above makes a distinction between learning for summative assessment, and learning skills and competences that will be important in later life (Boud and Falchikov, 2006). The student is attributing value to the process of learning and its meaning, rather than to the acquisition of grades.

In addition to this, students noted that it was the design of the course itself that was leading them to engage with the research more closely. In fact, from what this student says there was a sense in which he feels that he had no choice but to engage with the research. It was the module structure and approach that was 'forcing' him to do this:

'The most important element of the course is the design of the course. The course is designed in such a manner that it forces research and development, it's not like bookwork or something like that, or you have to refer to this book... And it's designed like in such a manner that you have to think in your own way. That's the most important thing.'

The student notes that this engagement with research also led him to have to develop an autonomous approach to engaging with the concepts and ideas of the course.

The importance of engagement with both the tutor and the tutor's research

Davies et al (2006) canvassed engineering students' views of 'what makes a good lecturer', and found that '*uses real-world engineering examples backed up by industrial experience*' was one of the three most significant answers (2006: 545). This is echoed in this study, where students also attributed particular significance to the role of the tutor and their research in their modules. Despite the limited face-to-face student to staff contact for the module, (that is part of the gradual but sustained reduction in contact time endemic in Higher Education across the UK), the students in this study still fore-grounded the contribution of individual conversation and discussion with their tutor. Students indicated that this academic interaction with staff supported the development of their ideas, and enabled them to develop perspectives on their approach to their own research. One student notes:

'When we go and see him, he looks and then he'll tell us other areas that he thinks will be applicable to that area of study that we are doing. So that sort of broadened my scope of looking at more things and incorporating more into the report that I was doing. So it

helps when people give you a different perspective on what they think will be included, and then not only do you look at that but then that'll lead you on to something else...

Thus, engagement with the tutor is a first step towards expanding students' own ideas, developing wider perspectives on the subjects being studied, and engaging with research and enquiry in their own right. The student's use of the first person in this quote is interesting, and the labeling of his perspective on his work as '*my scope*' indicates that he feels ownership of his work. He also feels that whilst the tutor's comments are a guiding factor, he is the person driving the research he is involved in.

The influence of social, cultural and personal factors

There was a strong acknowledgement by students interviewed of the positive effect of both cultural and academic diversity in the group, and of its role in supporting and improving their learning. In line with research that suggests that international learning communities are significant in studying engineering (Borri, Guberti and Melsa, 2007), students expressed a desire to seek out diversity as a means of improving the quality of their learning. One student noted:

'I just want to sit with other people so I can find out their way of approaching things, so that I can learn something or I can teach something'.

At the same time, however, students were also aware of the difference in some students' skills and competencies in particular areas. This was viewed as an influencing factor on the quality of the learning of the group as a whole. This produces a more negative view of unequal distribution of peer competencies. One student identifies competency with computers as one of these areas, where students' prior knowledge of the software and technology varies considerably from student to student. The differentials in competencies such as computing influence the whole group experience, and can also affect perceptions of the course.

Goodyear and Zenios note that:

'A strong element of [the] socio-cultural view of learning is that participation in authentic knowledge-creation activities, coupled with a growing sense of oneself as a legitimate and valued member of a knowledge-building community, is essential to the development of an effective knowledge-worker' (2007: 5-6).

This view of the significance of the socio-cultural view of learning is one that is upheld by this paper. It may be the case that in the past, Engineering Education has paid too little attention to this aspect of learning (Borri, Guberti and Melsa, 2007; Abanteriba, 2006), focusing instead on the development of skills in particular areas, such as maths and physics. The increased inclusion of the use of tutors' own research as examples in teaching begins to address this, by enabling students to see the people attached to enquiry and to follow the lines of reasoning and thought explained by the tutor himself. As students become engaged with research and enquiry of their own, they begin to see themselves as part of real knowledge-generating activities. From there, they may begin to develop their own identities as Engineering professionals, part of a community of Engineers engaged in enquiry.

Students interviewed in this project appeared to fore-ground a sense of themselves as Engineers, and also placed emphasis on the social and personal factors that had contributed to them deciding to become an Engineer. Being an Engineer was termed '*a childhood dream*', and in some cases was motivated by a desire to be able to call themselves '*an Engineer*'. Despite the fact that all students held engineering qualifications on entry, there was variation in whether students felt that

they could say they were Engineers at this point in their course. Students saw their experience at university as a holistic development, in which social, cultural and personal factors played a significant part in their success. When a student was asked about factors that had contributed to his success he responded:

'It was a blend. Each and every thing has contributed to it and it could be foolish on my part to say that, yes, this was the thing. It was a whole, everything as a whole came out to be the success, including my enjoyment of the nightlife here. [not] just going through [engineering, engineering, engineering]... One needs to enjoy nightlife. Apart from university, the atmosphere here also contributed to my success.'

Findings: the analysis of students' summative assessment

Figure 1 below shows an analysis of the students' summative assessment results at the end of the project compared with the results of the previous student cohort in the academic year 2006-7.

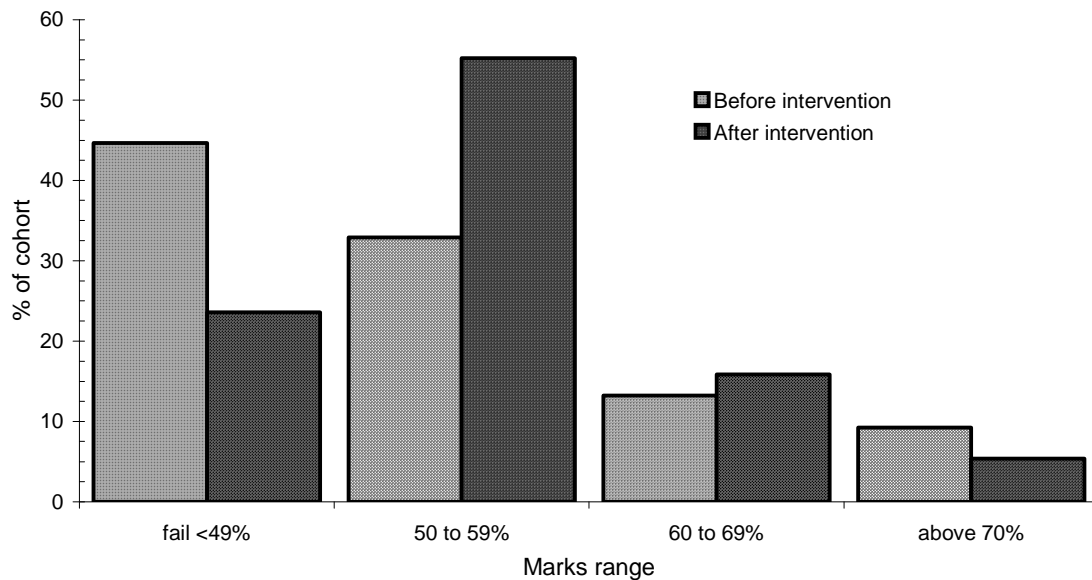


Figure 1 Module outcome by marks range, pre and post intervention

Although this work is ongoing it is possible to observe an early indication of the potential impact from the summative marks obtained in two of the modules taken by the cohort contributing to the current study.

The teaching, learning and assessment strategies employed included the use of formative worksheets, technical coursework essays and in-depth investigations and evaluations of 'real world' problems, in addition to the intensified focus on tutors' own research. This differed from previous years in that both formative and summative tasks were based upon activity which attempted to mirror approaches taken within engineering research. An example would be the use of published material in tasks which required the student to practice comprehension, distillation and critical analysis of unfamiliar technical situations and problems.

The results presented in figure 1 have been obtained for three modules prior to the intervention and two post intervention. It may be observed that there is a clear impact upon the proportion of students who have made a transition between weak engagement and failure and there was a growing engagement and achievement of threshold performance. Further support for the

proposition that some students were already engaged prior to the intervention may be drawn from the lack of any impact on student performance at the upper end of the marks range. We are encouraged by these results as they were obtained by students who were predominantly in their first semester (of three) and therefore we would hope to see some progression of student performance into the higher marks range as early engagement with the subject is further developed.

Conclusions

The research and analysis described in this paper are still ongoing. The results reported here are part of a work in progress. It is intended that this detailed profiling of students will enable a compilation of indicators of success, or barriers to success, from within this complex student group.

It is important to acknowledge here the authors' awareness of the fact that innovations in teaching and learning take place against a backdrop of a complex social, cultural and academic environment. The implementation of new approaches to teaching, learning and assessment such as those championed by the AfL approaches involves consideration of aims and principles, along with careful planning. However, in the micro-context of the 'classroom', it is an evolving activity, influenced by teacher reflection-in-action, student responses, and a wide range of contextual factors, many of which are unpredictable.

Educational research has shown that perceptions held by students, teachers and other participants in the learning context are crucial to the experience and outcomes of learning (Prosser and Trigwell, 1999). The work done undertaken in this paper so far has underlined the fact that student perceptions are being influenced. Also, students are fore-grounding research, enquiry and the process of learning as a way of developing important and life-long skills, rather than focusing on simply passing their exams. Goodyear and Zenios outline the continuing significance of students' views of what they are doing:

'Students are active interpreters of their learning environment and... variations in their understanding of learning, and in their interpretations of tasks being set for them result in differences in study behaviours that can in turn affect learning outcomes' (Goodyear and Zenios, 2007: 1).

Whilst it is the process of learning and being involved with enquiry that is significant, assessment should also *'facilitate the conduct of enquiry'* (Kahn and O'Rourke, 2007). If the approaches implemented and the exemplars of enquiry in these Engineering modules do not have an impact on student achievement, it may therefore be interesting to investigate the alignment of the assessment with the specific enquiry involved in the module itself.

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